

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
8 March 2001 (08.03.2001)

PCT

(10) International Publication Number  
**WO 01/15597 A1**

(51) International Patent Classification<sup>7</sup>: **A61B 5/00**

(74) Agent: PRINS, Ir., A., W.; Vereenigde, Nieuwe Parklaan  
97, NL-2587 BN The Hague (NL).

(21) International Application Number: PCT/NL00/00604

(22) International Filing Date: 30 August 2000 (30.08.2000)

(25) Filing Language: Dutch

(26) Publication Language: English

(30) Priority Data:  
1012943 31 August 1999 (31.08.1999) NL

(71) Applicant (for all designated States except US): NED-  
ERLANDSE ORGANISATIE VOOR TOEGEPAST-  
NATUURWETENSCHAPPELIJK ONDERZOEK  
TNO [NL/NL]; Schoemakerstraat 97, NL-2628 VK Delft  
(NL).

(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,  
DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,  
LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,  
NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM,  
TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,  
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(72) Inventor; and

(75) Inventor/Applicant (for US only): WIERINGA, Fokko,  
Pieter [NL/NL]; Zadelmakerstraat 21, NL-6921 JA Duiven  
(NL).

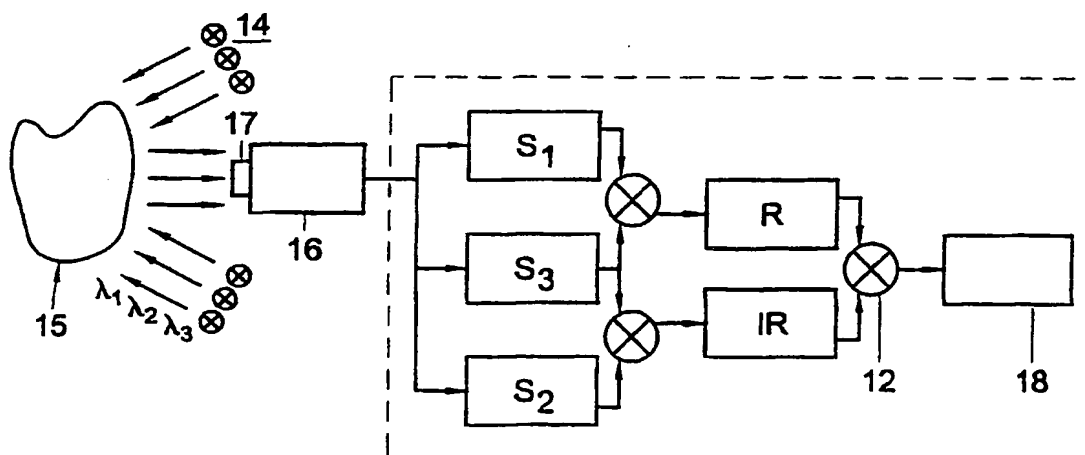
Published:

- With international search report.
- With amended claims.

Date of publication of the amended claims: 3 May 2001

[Continued on next page]

(54) Title: IMAGING APPARATUS FOR DISPLAYING CONCENTRATION RATIOS



(57) Abstract: Imaging apparatus for representing an image of concentration ratios between a first and a second substance in a region of interest of an object, with different measuring values being represented with different colors and/or gray shades. The apparatus comprises a light source capable of irradiating the object with light, which light comprises at least three wavelengths  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$ ,  $\lambda_3$  being an isobestic wavelength,  $\lambda_1$  being a wavelength at which the first substance has a lower absorption than the second substance, and  $\lambda_2$  being a wavelength at which the first substance has a higher absorption than the second substance. The apparatus further comprises detection means comprising a matrix of pixel detectors, for representing a virtually instantaneous image of the region of interest.

WO 01/15597 A1

**WO 01/15597 A1**

---



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## AMENDED CLAIMS

[received by the International Bureau on 19 February 2001 (19.02.01);  
original claim 1 amended; remaining claims unchanged (2 pages)]

1. An imaging apparatus for representing an image of concentration ratios between a first and a second substance in a region of interest of an object, with different measuring values being represented with different colors and/or gray shades, comprising
- 5 - a light source capable of irradiating the object with light, which light comprises at least three wavelengths  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$ ,  $\lambda_3$  being an isobestic wavelength, being a wavelength at which the first substance has a lower absorption than the second substance, and  $\lambda_2$  being a wavelength at which the first substance has a higher absorption than the second substance;
- 10 - detection means for at least detecting the intensity of light emitted by the object at the respective wavelengths  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$ , resulting in detection signals  $S_1$ ,  $S_2$  and  $S_3$ ;
- a processing unit for calculating an optical image of the pattern of concentration ratios, from the respective signals  $S_1$ ,  $S_2$  and  $S_3$ ;
- 15 - display means for displaying the calculated optical image;
- characterized in that the detection means comprise:
- a 3CCD camera, each of the 3 CCDs of said camera being adapted for receiving one of said wavelengths  $\lambda_1$ ,  $\lambda_2$ ,  $\lambda_3$ , the CCDs of said camera generating signals  $S_1$ ,  $S_2$ ,  $S_3$  respectively, to be processed in said processing unit, thereby
- 20 representing a virtually instantaneous image of the region of interest.
2. An imaging apparatus according to claim 1, characterized in that the apparatus is arranged for forming an image of visible light and that the pattern of concentration ratios is projected in one overlapping image with the
- 25 visible image.

3. An imaging apparatus according to at least one of claims 1-2, characterized in that the light signals of wavelengths  $\lambda_1$ ,  $\lambda_2$  en  $\lambda_3$  have a characteristic modulation.
- 5 4. An imaging apparatus according to claim 3, characterized in that it is arranged, given an assumed cyclic change of the concentration ratio, such that it can analyze the spectral features in the frequency domain thereof.
- 10 5. An imaging apparatus according to any one of the preceding claims, characterized in that to determine the ratio of hemoglobin and oxyhemoglobin in blood, with said first and second substance being hemoglobin and oxyhemoglobin, respectively, the signal sources are so arranged that the first wavelength  $\lambda_1$  is in the wavelength range of 600 to 700 nm, with a preference for 660 nm, the second wavelength  $\lambda_2$  is in the wavelength range of 900 to 1000
- 15 nm, with a preference for 940 nm, and the third wavelength  $\lambda_3$  is in the wavelength range of 790 to 830 nm, with a preference for 810 nm.